The temporal variability of land-atmosphere coupling regimes in the Southeast United States

Joshua. K. Roundy
Department of Civil and Environmental Engineering, Princeton University, Princeton, New Jersey, USA.
Craig R. Ferguson
Department of Hydrology and Water Resources Engineering, Institute of Industrial Science, The University of Tokyo, Tokyo, Japan
Eric. F. Wood
Department of Civil and Environmental Engineering, Princeton University, Princeton, New Jersey, USA.

Extreme hydrologic events in the form of droughts are a significant source of social and economic damage in the Southeast United States. Having sufficient warning of these extreme events allows managers to prepare for and reduce the severity of their impacts. A seasonal hydrologic forecast system can provide early warning; however the skill of the forecasts greatly depends on the skill of the precipitation forecast. The skill of the precipitation forecast from coupled land-atmosphere-ocean models is the lowest during the warm season. Predictions of precipitation during the warm season are complicated by the land-atmosphere interaction that can impact the growth and attributes of the atmospheric boundary layer through the surface heat and moisture fluxes. The degree to which this signal affects the precipitation event frequency and depth varies regionally and seasonally. To better understand the limitations and possible areas of potential predictability the temporal variability of land-atmosphere interactions needs to be understood. Previous studies have classified regions into coupling regimes based on the tendency of land surface soil moisture anomalies to enhance convective triggering. Up until now, the regime classifications have been made for the long-term dominant feedback signal. Such a classification does not sufficiently convey the temporal variability of coupling. To better understand this aspect of coupling, we propose a new classification capable of diagnosing coupling signal on a daily basis. The classification is based on joint probability space of surface soil moisture and convective triggering potential (CTP) and the low-level humidity index (HI). The CTP and HI are calculated based on reanalysis data from the Modern Era Retrospective-analysis for Research and Applications (MERRA), along with remote sensing measurements from the Atmospheric Infrared Sounder (AIRS). The soil moisture data is from Advanced Microwave Scanning Radiometer (AMSR-E) and the Variable Infiltration Capacity (VIC) hydrological model forced by observed precipitation, temperature and wind from the National Land Data Assimilation System (NLDAS). Different combinations of datasets were used to classify coupling regime based on the joint probability distributions of soil moisture and CTP-HI. Spatial and temporal consistency between the datasets in terms of the classification of coupling is analyzed. Furthermore the correlation of daily coupling regime class with hydrologic drought intensification and precipitation forecasts from the NCEP Climate Forecast System (CFS) over the southeastern United States is evaluated. The results show that using this method of classification of coupling gives generally consistent results for all combinations of datasets. In addition variations from the climatology of land-atmosphere coupling regimes can lead to intensification of drought during the convective season and that the monthly precipitation forecast bias shows a consistent relationship with the frequency of different coupling regimes. Furthermore, the implications of using this framework for assessment and inter-comparison of reanalysis data in terms of land atmosphere interactions could lead to a better representation of coupling in models, which could lead to more skillful forecast during the convective season.

Corresponding Author:

Name:	Joshua K. Roundy
Organization:	Department of Civil and Environmental Engineering, Princeton University
Address:	Engineering Quad Room E209 A P Princeton, NJ 08544 USA
Email Address:	jroundy@princeton.edu